

MISSOURI

LIVESTOCK WATERING SYSTEM HANDBOOK

October 1, 1997

Natural Resources Conservation Service
Columbia, Missouri

ACKNOWLEDGEMENTS -- A lot of the material was prepared and published earlier by NRCS/SCS in Montana

MISSOURI LIVESTOCK WATERING SYSTEMS HANDBOOK

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

PART 1.1	PURPOSE AND OBJECTIVES	1-1
PART 1.2	GENERAL	1-1
PART 1.3	GLOSSARY	1-2
PART 1.4	CONVERSIONS AND ABBREVIATIONS	1-15

CHAPTER 2 PLANNING CONSIDERATIONS

PART 2.1	GENERAL	2-1
PART 2.2	PLANNING PROCEDURE	2-3
	2.2.1 Objectives	2-3
	2.2.2 Resource Inventory	2-3
	2.2.3 System Alternative	2-3
	2.2.5 Implementation	2-4
	2.2.6 Follow-up	2-4
PART 2.3	WATER QUANTITY REQUIREMENTS	2-4
PART 2.4	PIPELINE DELIVERY RATES	2-4
PART 2.5	WATER STORAGE REQUIREMENTS	2-5
PART 2.6	SOURCE OF WATER	2-6
	2.6.1 Springs	2-6
	2.6.2 Surface Source	2-7
	2.6.3 Well	2-7
	2.6.4 Rural Water	2-7
	2.6.5 Water Quality	2-7

CHAPTER 3 PIPELINE SYSTEM TYPES

PART 3.1	GENERAL	3-1
PART 3.2	GRAVITY SYSTEM	3-1
	3.2.1 Low Pressure Gravity System	3-1
	3.2.2 High Pressure Gravity System	3-3
PART 3.3	AUTOMATIC PRESSURE SYSTEM	3-3
PART 3.4	TIMED OR MANUAL PRESSURE SYSTEM	3-3
PART 3.5	FLOAT SWITCH OPERATED PRESSURE SYSTEM	3-3
PART 3.6	ALL YEAR VERSUS SUMMER PIPELINES	3-9
	3.6.1 Summer Pipeline	3-9
	3.6.2 All Year Pipeline	3-9

CHAPTER 4 PIPELINE ROUTE SELECTION AND SURVEYS

PART 4.1	ROUTE CONSIDERATIONS	4-1
PART 4.2	ROUTE SURVEYS--GENERAL	4-2
PART 4.3	ENGINEERING INSTRUMENT SURVEY	4-2
PART 4.4	USE OF USGS QUAD MAPS	4-2

MISSOURI LIVESTOCK WATERING SYSTEMS HANDBOOK

TABLE OF CONTENTS (continued)

CHAPTER 5 PIPE DESIGN

PART 5.1	GENERAL	5-1
PART 5.2	PLASTIC PIPE CHARACTERISTICS	5-1
	5.2.1 Pressure Rating Pipe	5-1
	5.2.2 How Temperature Affects Pressure Rating	5-2
	5.2.3 Freezing of Water In Pipe	5-3
PART 5.3	POLYVINYL CHLORIDE (PVC) PLASTIC PIPE	5-3
PART 5.4	POLYETHYLENE (PE) PLASTIC PIPE	5-4
PART 5.5	ACRYLONITRILE-BUTADINE-STYRENE (ABS) PLASTIC PIPE	5-5
PART 5.6	POLYBUTYLENE (PB) PLASTIC PIPE	5-5
PART 5.7	STEEL PIPE	5-5
PART 5.8	FRICITION LOSS IN PIPING SYSTEM AT THE PUMP	5-6
PART 5.9	PIPE FRICTION LOSS TABLES	5-9
PART 5.10	PCV PIPE FITTINGS	5-16

CHAPTER 6 PRESSURE AND SURGE CONTROL

PART 6.1	PIPELINE PRESSURE CONTROL	6-1
	6.1.1 Need for Pressure Control	6-1
	6.1.2 Pressure Reducing Valves	6-1
	6.1.3 Grade Break at Tank	6-4
PART 6.2	SURGE CONTROL	6-6
	6.2.1 Pressure Tank as Surge Chamber	6-6
	6.2.2 Minimize Frequency of Pump Cycle	6-7
	Flow Control Valve	6-9
	Flow Controlled Pressure Switch	6-9
	Pump Cycle Timer	6-9
	6.2.3 Install Air Valves	6-11
	6.2.4 Use Slow Closing Valves	6-11
	6.2.5 Control Flow Rate at Float Valve	6-11
	6.2.6 Operation Plan	6-11

CHAPTER 7 AIR CONTROL

PART 7.1	GENERAL	7-1
PART 7.2	AIR GAS/PROBLEMS	7-1
PART 7.3	AIR IN LOW HEAD GRAVITY PIPELINES	7-3
PART 7.4	AIR CONTROL IN HIGH HEAD, LONG PIPELINES	7-3
PART 7.5	HOW AIR VALVES WORK	7-8
PART 7.6	AIR VALVE INSTALLATION	7-12

MISSOURI LIVESTOCK WATERING SYSTEMS HANDBOOK

TABLE OF CONTENTS (continued)

CHAPTER 8 PIPELINE SYSTEM ACCESSORIES

PART	8.1	SPRING FED PIPELINE ENTRANCE	8-1
PART	8.2	WELLS AND SUMPS	8-5
PART	8.3	PUMPS	8-5
	8.3.1	Submersible Electric Pump, Jet, Turbine and Piston Pump. For Details see MWPS-14.	8-5
	8.3.2	Windmill	18-5
	8.3.3	Wind Generator Powered Pump	8-10
	8.3.4	Solar Powered Pump System	8-11
	8.3.5	Internal Combustion Engine Powered Pumps	8-14
	8.3.6	Hydraulic Rams	8-15
PART	8.4	PRESSURE TANKS	8-18
	8.4.1	Plain Pressure Tank	8-19
	8.4.2	Diaphragm-Type Tank	8-21
	8.4.3	Tank Pressure Rating	8-21
	8.4.4	For additional details for Pressure Tanks See MWPS-14.	8-21
PART	8.5	PRESSURE SWITCHES	8-32
	8.5.1	Switch Characteristics	8-32
	8.5.2	Pressure Gauges	8-32
PART	8.6	ELETRICAL PUMP CONTROL EQUIPMENT	8-33
	8.6.1	Automatic Water Level Control	8-33
	8.6.2	Remote Control Pump Float Switch	8-35
PART	8.7	STOCKWATER TANKS	8-37
	8.7.1	Tank Materials	8-37
		Concrete Tanks	8-37
		Fiberglass Tanks	8-43
		Plastic Tanks	8-43
		Galvanized Steel Tanks	8-45
	8.7.2	Water Inlet Protection including Float Valve	8-49
	8.7.3	Protection Around Tanks	8-53
	8.7.4	Tank Overflows	8-53
	8.7.5	Inlet to Pipeline from Tank	8-55
PART	8.8	STORAGE TANKS	8-56
PART	8.9	PIPELINE DRAINS	8-62

CHAPTER 9 SYSTEM DESIGN PROCEDURES

PART	9.1	GENERAL	9-1
PART	9.2	EXAMPLE 1, LOW PRESSURE GRAVITY SYSTEM	9-1
PART	9.3	EXAMPLE 2, PUMPED AUTOMATIC PRESSURE PIPELINE	9-5
	9.3.1	Pumped Automatic Pressure System Computations	9-5
	9.3.2	Lateral Computations	9-6
PART	9.4	EXAMPLE 3, TIMER OR MANUALLY OPERATED PRESSURE SYSTEM	9-11
	9.4.1	Timer or Manually Operated Pumped System Computations	9-11
	9.4.2	Gravity Line Computations	9-15
	9.4.3	Lateral Computations	9-16
PART	9.5	EXAMPLE 4, PRESSURE REDUCER	9-18

MISSOURI LIVESTOCK WATERING SYSTEMS HANDBOOK

TABLE OF CONTENTS (continued)

CHAPTER 10 PIPELINE INSTALLATION

PART	10.1 TRENCHING	10-1
	10.1.1 Backhoe Constructed Trench	10-1
	10.1.2 Trencher Constructed Trench	10-1
	10.1.3 Backfilling and Maintenance	10-1
	10.1.4 Road Crossings	10-2
	10.1.5 Safety	10-2
PART	10.2 PIPE JOINTS	10-4
PART	10.3 INSPECTION DURING CONSTRUCTION	10-4
PART	10.4 MEASUREMENT FOR PAYMENT	10-4

CHAPTER 11 OPERATION, MAINTENANCE AND REPLACEMENT

PART	11.1 GENERAL	11-1
PART	11.2 WINTERIZING	11-1
PART	11.3 OPERATION AND MAINTENANCE PLAN	11-1
PART	11.4 REPLACEMENT	11-1

APPENDIX A WORKSHEETS

APPENDIX B COMPUTER PROGRAMS

APPENDIX C MATERIALS SOURCES

APPENDIX D PLANNING AND DESIGN GUIDE

APPENDIX E REFERENCES